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Integrating Research and Resource Management

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EXPOSURE OF SNOWMOBILE RIDERS TO CARBON MONOXIDE

Emissions Pose Potential Risk

BY LORI MARIE SNOOK FUSSELL

SNOWMOBILE travel (fig. 1) has become pervasive recreation in several national parks. During winter 1993-94, more than 87,000 tourists visited Old Faithful in Yellowstone National Park (Wyoming, Montana, Idaho) by snowmobile alone. Experts had predicted it would take 10 years for winter tourism to reach the 1993-94 level; however, it took only three (Wilkinson 1995; Thuermer 1996). Voyageurs National Park in Minnesota also experiences significant snowmobile traffic, with an estimated 30,000 snowmobiles entering annually (Wilkinson 1995). Snowmobile travel is also gaining popularity in many other national parks, such as Mount Rainier, Olympic, Grand Teton, and North Cascades (Wilkinson 1995).

LORI M. SNOOK FUSSELL

Figure 1. Snowmobile travel is gaining popularity in national parks, including Grand Teton National Park, Wyoming, the site of the recent emissions study.

Presently, no federal laws regulate the exhaust from snowmobile engines. The typical snowmobile operates on a small, two-stroke engine (around 400-650 cc). The two-stroke engine is less expensive than its four-stroke counterpart and provides a high power:weight ratio. However, it also produces relatively high emissions of carbon monoxide (CO) and unburned hydrocarbons (UHC) (White et al. 1993). Additionally, snowmobile engines are not equipped with pollution control equipment. Therefore, the typical snowmobile produces significantly more CO and UHC than a modern automobile.

HEALTH HAZARDS

Carbon monoxide is a colorless and odorless gas that results from incomplete combustion. It is considered dangerous because it binds to the hemoglobin in blood (forming carboxyhemoglobin) and renders the hemoglobin incapable of transporting oxygen. The amount of carboxyhemoglobin and thus the effect on health is a combination of the concentration of CO in the air and the time of exposure. When exposure is discontinued, the CO that combined with the hemoglobin is spontaneously released, and the blood of healthy individuals is cleared of half of its CO in 3-4 hours. The effects on health range from neural-behavioral effects at 2-3% carboxyhemoglobin to headaches and fatigue at 10% carboxyhemoglobin to respiratory failure and death. Reduced blood-oxygen levels from CO exposure are particularly dangerous to the elderly, people with cardiovascular disease or other circulation problems, anemic individuals, fetuses, young infants, and pregnant women (U.S. Environmental Protection Agency 1991).

The National Ambient Air Quality Standard (NAAQS) for CO is 35 ppm (parts per million) for 1 hour and 9 ppm for 8 hours. This standard was established to keep blood levels of carboxyhemoglobin below 3%. However, some evidence sug-

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IN THE NEXT ISSUE. . .

Lake Mead Wildlife Biologist Mike Boyles will share his perspective on desert tortoise research, protection, and recovery in the Mojave Desert parks.

BRINGING OUT THE BEST IN US

OPPORTUNITY AND *PROGRESS* DESCRIBE MY SENSE OF THE NINTH GEORGE WRIGHT SOCIETY conference that took place in Albuquerque last March. From the showing of 560 resource managers, scientists, and administrators (50-60% from this agency), we clearly embraced this important biennial gathering of colleagues dedicated to preserving resources through research and management. Three regional directors attended, and at least 36 park superintendents or assistant superintendents were there contributing to the lively session and hallway discussions that characterized this upbeat professional science and resource management conference.

While this level of participation apparently reflects a strong concern for resource preservation at present, it come in cycles. The 1976 conference in New Orleans was also well attended by managers, but in 1990, some managers questioned the legitimacy of sending members of their own resource management staffs to the El Paso meeting!

This was a wonderful opportunity to learn about new research and discuss its application in park management. Over the course of 5 days, nearly 200 formal presentations took place and 70 posters were presented. Hallway discussions were numerous and productive, with conference-goers getting acquainted or exploring solutions to parallel problems from different parks. "The conference provides a connection that is a tonic for insularity," noted past George Wright Society President Gary Davis. "It makes us feel better about our own world."

George Wright was a revolutionary. He briefly succeeded in bringing a biologist's viewpoint to park management in the 1930s before his untimely death at a young age. Up against a deep-rooted tradition of providing for the enjoyment of parks by tourists, Wright sought to incorporate research into park management thinking. The relatively high turnout of managers at this meeting is an encouraging demonstration of support for resource preservation. Now we must try to keep this level of interest from waning.

Jeff

Corrections

Last issue, our review of the Ecological Society of America Conference–**16(4):**10–incorrectly listed the author, NPS Wildlife Biologist Michael Britten, as an employee of the Rocky Mountain System Support Office; he is with the Colorado Plateau Support Office. Britten also wrote to mention that he neglected to include a complete listing of all presentations made at the conference by NPS employees. Two that he left out were, "Applying conservation biology and ecosystem management in the Santa Monica Mountains National Recreation Area," by R.M. Sauvajot, D.A. Kamradt, R. Rumball-Petre, P. Jenkins, and J. Benedict. The other, "Evaluating bobcat viability in the Santa Monica Mountains, California," was presented by D.A. Kamradt and R.M. Sauvajot.

Park Science online was announced last issue in the News & Views department, but an incorrect World Wide Web address was given. The correct URL is *http://www.aqd.nps.gov/natnet/nrid/parksci.*

Dear Editor,

I want to clarify some inaccuracies in the article, "A Different Spin on SSO Support"–**16(4):**8. The story credits John Karish, Chief Scientist of the Allegheny-Chesapeake Support Office, as having placed the 4-year term NPS Natural Resource Specialist (Michele Batcheller) at Penn State. This was accomplished through the Resource Management and Visitor Protection Division at the former Mid-Atlantic Regional Office where Chris Andress was the Division Chief and I was the Natural Resource Branch Chief. As the article asserts, Karish has coordinated the regional, and now cluster, science program for the past 16 years, but not the Natural Resource Program. This has been my responsibility for the past 5 years, and Kathy Jope (now with the Columbia-Cascades Support Office) was responsible for it before me. Last fall, Wayne Millington, an integrated pest management specialist, became the third support office employee duty stationed at Penn State. Presently, I supervise all three of the NPS staff at Penn State.

Dave Reynolds
Manager, Park Planning & Natural Resources Group
Chesapeake-Allegheny Support Office

Report Tracks Issues and Trends in Resource Management

The long-awaited *Natural Resource Year in Review–1996* is now online at *http://www.aqd.nps.gov/natnet/pubs/yr_rvw96.* You can access it by visiting the NatureNet home page on the World Wide Web and clicking on the feature article image on that page. The printed edition should arrive in parks concurrent with this issue of *Park Science* and has been circulated to superintendents, division chiefs, and resource managers at all units of the national park system. It also has been given broad circulation beyond the National Park Service.

The report summarizes and analyzes the most significant natural resource issues and trends in the national park system for the calendar year. Applied science and resource management stories are reviewed with the objective of increasing interest in, understanding of, and support for the natural resource stewardship role of the National Park Service.

Stay tuned this fall for a call for article ideas for the 1997 edition of the report. Thanks to all who contributed to this inaugural report.

USGS Plans for Future

The U.S. Geological Survey (USGS) recently published a 68-page strategic plan for the agency that will guide it until 2005. The report examines the current socio-political environment and charts the general course for the agency over that time span. The document, which can be viewed in its entirety on the World Wide Web at *http://online.wr.usgs.gov/stratplan/splan/main.html*, addresses demographic changes, public investment in science, society's concept of "public good," economic versus environmental interests, and the scarcity and management of natural resources. The document also stresses the need for continuing partnerships and developing long-term national databases.

The plan clearly reflects a developing change in program emphases. Over the next 10 years, the agency will emphasize: long-term interdisciplinary studies, mitigation studies, quality and accessibility of resources, international mineral-energy studies, nontraditional disciplines, regional and national studies, geospatial data integration, applied research and development, technology transfer, engaging in controversial issues, issue-driven studies, studies involving population centers, multiple-risk assessments, digital products, and real-time event responses.

Issued in May 1996, just half a year after Congress directed the National Biological Service to consolidate with the U.S. Geological Survey and half a year before this actually happened, the report does not go into details about the merger. Instead, the 19-page *NBS Strategic Science Plan,* published last October, guides the initial scientific efforts of the new Biological Resources Division (BRD) within the parent 118 year-old science agency.

Last October 1, the consolidation of the two agencies took place and BRD became the fourth division of the USGS, alongside water resources (the largest), geologic resources, and national mapping. Denny Fenn, former acting NPS Associate Director for Natural Resources and recently the NBS Western Regional Director, was appointed the first Chief Biologist of the new division.

Addressing a plenary audience at the George Wright Society conference last March, Fenn pointed out some benefits to the National Park Service of his division being situated with USGS. Many of the former cooperative park studies units, which are base funded, will be reestablished as park field stations, making them more accessible to parks. Furthermore, the BRD supports the establishment of cooperative ecosystem studies units and will share its key skills to make the proposal work.

Now, we must not turn our backs on the new division. We have the opportunity to forge partnerships with them, which will help form an agency culture that is responsive to our needs. Let us start by learning who to call and asking for assistance.

WILD FORESTS, CONSERVATION BIOLOGY, AND PUBLIC POLICY

By Alverson, Kuhlmann, and Waller

A BOOK REVIEW BY ROBERT G. WILLHITE

HOW MUCH OF EACH TYPE OF FOREST must be set aside in a preserve to ensure its perpetuation? This age-old question is the premise of the consciousness-raising book, *Wild Forests, Conservation Biology and Public Policy.* Accompanied by an impressive literature review, the work examines the conservation ethic, history, law, and natural forest dynamics as they relate to preserving forest resources. The USDA Forest Service and its "multiple use" management policies are criticized for not adequately protecting forest lands, with some mention of the USDI, Bureau of Land Management. One solution the authors propose is to reassign the biodiversity protection responsibilities to another agency. The National Park Service might fit their model. The authors maintain views that closely fit the resource *conservation* mandates of the NPS Organic Act (legally interpreted as preservation), and they write that national parks and wilderness areas could form the core of many of the needed forest preserves.

On public lands where timber harvesting is part of multiple use, the authors propose that forest management planning should "require proof of harmlessness to be furnished by those who propose intensive disturbance of the landscape." Thus, they demand the impossible of these other federal agencies because throughout the book they "readily admit that vast amounts of this information are unknown to us all." Such an unrealistic view only further frustrates resolution of important issues and does not help the agencies charged with making appropriate environmental decisions. This unreasonable expectation clouds their otherwise valid discussion to seek change in forest management. In general, the authors present concepts that need consideration by foresters, land managers, agencies, and timberland owners alike.

GUILT—REASON FOR CHANGE?

Early in the text, the authors succumb to, or apply, a popular belief that *guilt* about past human activity is the reason we must make changes for the future. For example, they hold rigidly to the view that precolonial forests were pure and pristine. To the contrary, research in the early 1900s by Harvard University found that journals of colonists like Cotton Mather in the 1600s described forests whose trees, intolerant of shade, could not reproduce in late successional stages. Surprised, the Harvard researchers analyzed the "pit-mounds" associated with windthrown root wads, and found that the precolonial forests did not retain their "virgin"-ity. Massive periodic disturbance from hurricanes had occurred about every 150 years, sometimes associated with subsequent fire. Although the authors recognize and thoroughly discuss the role of such natural disturbances, they do not fully incorporate these concepts into their arguments for improved forest planning and management.

Their theme of guilt continues when they suggest that humans caused extinctions of the ground sloth, giant beaver, saber-tooth cat, and horse. This is a highly controversial premise with little scientific evidence to support it. Some kill sites of mastodons with indications of butchering by humans are known, as well as "jump sites" where bison were run off cliffs. Humans cannot be singled out as the cause of extinction, but may have added to the natural influences of vulcanism and climatic changes that forced adaptation or migration, in addition to extinction. The book effectively makes the point that changes in present forest management are needed without including these common guilt-directed justifications.

Wild Forests (©1994) *is available from*

Island Press
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Covelo, CA 95428
(800) 828-1302

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DIVERSITY MANAGEMENT AREAS

The authors call for diversity management areas (DMAs)–large tracts of forest that include old-growth and some natural disturbance–as a solution to the problem of diminishing forest resources (fig. 1). The DMA model uses concentric rings where management is minimal in the center and more intense on the periphery. This concept was taught in forestry schools in the late 1960s and is now widely applied in the protection of wilderness areas. They state that timber and game management, and many forms of recreation, would be focused elsewhere but they do not propose where. They recommend that the minimum-sized DMA be about 50,000 acres or roughly 75 square miles. They state that domestic law and policy need emphasize management precautions to prevent a loss in biodiversity. Their charge

that species and site management need to be changed is well supported in their case studies and citations.

SOCIAL FACTORS

The authors do not address a dilemma in their call for natural disturbances by fire, wind, and ice damage; society probably will not tolerate *extensive* losses of forest resources imposed by unchecked natural processes in the East and many areas in the West. Policies can be formulated that consider both the benefits of periodic fire, and weigh the potential risks of allowing fires to burn. An example is the NPS policy of fire control in wilderness areas, developed after the Yellowstone conflagrations. After extensive wind damage, managers typically consider reforestation efforts or wood salvaging operations to reduce wildfire risks.

Addressed at length are the problems of fragmentation, "edge effects" from harvesting, and roads caused by rapidly increasing human infrastructure in much of our forest landscape. However, they never suggest how to resolve these problems. They also note the jurisdictional challenges posed by state, county, and private ownership of forest lands that would need to be addressed for DMAs to succeed in the eastern United States. They fail to mention a similar, widespread situation in the Sierra-Nevada mountains of California and Oregon where land ownership is fragmented as a result of railroad land grants meant to encourage westward expansion. Land acquisition by government is an integral part of their proposed solution, albeit not a popular one at present.

JEFF SELLECK

Figure 1. The diversity management area idea proposed by the authors focuses on the preservation of large blocks of relatively unmanaged lands. Falling short of wilderness designation, the (lack of) management scheme concentrates consumptive and recreation uses elsewhere to conserve old-growth forest and biodiversity.

A major factor not pursued in their discussions is economics. As the U.S. government withdraws lands from timber harvest, it also reduces revenues to the U.S. Treasury. Reduced federal budgets affect agencies and their abilities to manage forest resources. How can lost production on federal lands be offset by more intense management on private forest lands? Only about 14% of the nation's forests is owned by industrial timber companies but more than 50% is owned by smaller, private entities; economics is the primary force affecting their decision whether to harvest or not. Reduced taxes for incentives further limits potential treasury funds. These issues will require close examination and resolution before the authors' ideas can be put in to practice.

INFORMATION NEEDED

A key point made regarding managed forest lands is that human-applied processes must imitate nature. In citing forestry professor Jerry Franklin's "biological legacy" of leaving undisturbed remnants in managed areas, the authors furthered their call for responsible forest management. Foresters would probably provide the greatest environmental benefit by reflecting upon and applying these simple techniques. Conscientious foresters want to take good care of their lands, think they have most of the solutions, and believe that they understand the ramifications of their actions. Unfortunately, the authors correctly note, despite good intentions, many management decisions are not backed by complete information.

The authors make a clear and concise case for the importance of research and inventory and monitoring, matched with appropriate budgets. According to them, a separate agency, such as the National Biological Service (now the USGS Biological Resources Division), is the best way to meet this charge.

It would be interesting to hear the authors' opinions of some of the ongoing ecosystem management plans, such as the Snake and Columbia River systems in the West. One might guess that they would consider any planning venture to date as inadequate because necessary information is not yet available. Have the authors provided the solution for preserving forest biodiversity? Time and society will decide.

PS

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GULF COAST

Barrier Island Habitat Restored

Hurricane Opal made landfall on October 4, 1995, just east of the Florida District of Gulf Islands National Seashore, Florida and Mississippi. Most of this district is located on Santa Rosa Island, which is over 40 miles long and runs east to west. It is bordered by the Gulf of Mexico to the south and Escambia Bay and Santa Rosa Sound to the north.

The morphology of the island was altered as a result of the storm surge. Frontal dunes were leveled and sand was deposited inland forming vast tracts of sand fields. The surge caused extensive damage to Fort Pickens Road and State Road 399, the park's main roads, which were breached in numerous places and severely eroded elsewhere.

The storm surge deposited pieces of asphalt north of the roads and inland for over 4 miles in one area and 7 miles in another. Some of the pieces were intact sections of highway ranging in size from that of a dining room table to smaller than a marble. The debris was plainly visible from the newly rebuilt roadways and the north shore beaches, and copious amounts were located in areas that had been used for nesting by Least Terns *(Sterna antillarum),* a threatened species in Florida, in the summer of 1995. We were concerned that these anomalous pieces of asphalt might affect where they would choose to nest in years to come.

This past winter, park resource managers began the almost insurmountable task of picking up the asphalt, piece by piece, and having it removed from the island. We gave thought to having an asphalt company recycle the pieces, but this was not practical because every chunk was covered with foreign material, primarily sand.

Volunteering to help on four occasions were groups of 10-40 individuals who cleaned some of the areas. Also, park staff hauled asphalt to the road using ATVs (all-terrain vehicles) outfitted with trailers. The volunteers used 5-gallon buckets to transport small pieces of asphalt to the road shoulder or dump in an ATV trailer.

The U.S. Marine Corps also helped out. Approximately 100 marines collected and hauled pieces of asphalt to the road shoulder. This work was performed in one day, and approximately 103 cubic meters (135 cubic yards) of asphalt were removed and placed along the road for pickup. A local waste company donated a 20-cubic yard construction debris dumpster to aid the clean-up.

The park contracted to have large pieces of asphalt removed with a front-end loader and dump trucks. This work was only performed in areas with little or no vegetation. The front end loader also removed the asphalt piles that volunteers had placed on the road shoulders.

Altogether, approximately 191 cubic meters (250 cubic yards) of asphalt were removed. The majority was picked up by hand and totalled approximately 119 cubic meters (155 cubic yards); another 73 cubic meters (95 cubic yards) were removed with front-end loaders.

What started out as a small effort grew into a large one. At first the job seemed nearly impossible, but with hard work and persistence we succeeded in removing a large percentage of the debris from this island ecosystem.

Hurricane a Boon to Nesting Terns

Our concern for nesting Least Terns was an important consideration in pursuing the arduous cleanup of asphalt from Gulf Islands National Seashore following Hurricane Opal (previous story). In addition to tearing up and redepositing the asphalt from park roads, the powerful hurricane transformed a 4-mile stretch of Santa Rosa Island from a dune field into a flat sand expanse with little or no vegetation. The storm surge spread old road bed material (gravel) and sand from the dunes over the northern half of the island creating, ironically, ideal nesting areas for these and other bird species. In the 1½ years since the hurricane, the Least Tern, Snowy Plover *(Charadrius alexandrinus),* Wilson's Plover *(Charadrius wilsonia),* and Black Skimmer *(Rynchops niger)* have all nested successfully and fledged young in the areas disturbed by the storm.

The park was not able to monitor the birds closely due to personnel shortages. However, staff made frequent observations of the birds from the road. While some areas were too far away to confirm the presence of a nest, at least 60 tern nests were observed in four separate colonies. At least four pair of Snowy Plovers nested near the tern colonies. Approximately 40 skimmers began nesting behavior in one colony, with all but one pair abandoning the area. At another area, Least Terns, Snowy Plovers, and Wilson's Plovers all nested successfully.

To protect the nesting birds, the park posted area closure signs near the colonies, which worked well to minimize disturbances. The U.S. Navy at Pensacola Naval Air Station agreed to divert most helicopter flights away from the birds, and by the end of June 1996, the terns were well on their way to having a successful nesting summer. The terns are nesting again this summer in greater numbers than last year.

ROCKY MOUNTAINS

Yellowstone Potpourri

The Wolves of Yellowstone, a new book by Yellowstone National Park biologists Mike Phillips and Doug Smith, along with photographers Barry and Teri O'Neill, was recently published by Voyageur Press. Royalties from the sale of the book support the Yellowstone wolf restoration project.

The Interagency Grizzly Bear Study Team has documented a record year in 1996 for reproduction in the greater Yellowstone grizzly bear population: 33 different female bears produced 70 cubs-of-the-year (average litter size 2.1 cubs per litter). This is the highest number of unduplicated female grizzlies with cubs ever counted in the ecosystem in 1 year. The highest number of females with cubs previously counted was 25 in 1986. The most cubs previously counted was 57 in 1990.

The park is participating in a cooperative study to sample grizzly bear DNA from hair samples collected at specially designed hair-snagging "trap" sites. One long-term objective of the study is to develop an alternative method for estimating minimum grizzly bear population numbers within portions of the ecosystem. In 1996, the study concentrated on determining an effective, easy-to-handle bear attractant that could be used without giving bears a food reward. Lab work for determining how many individual grizzly bears the collected hair samples represent should be finished by the spring of 1997. If

all goes well the study will be continued in the summer of 1997 with emphasis on determining the optimum spacing distance of hair-collection sites for the most cost-effective means of sampling the population.

Biologists report that a total of 786 lake trout were taken from Yellowstone Lake in 1996 by gillnetting operations and park anglers. The nonnative fish, discovered in 1994, poses a serious threat to the native Yellowstone cutthroat trout. Researchers located a major spawning area around Carrington Island in the West Thumb of the lake during summer 1996, and are using information collected in 1995-96 to develop a long-term program to control the invader fish.

COLORADO PLATEAU

Interagency Fish Management at Glen Canyon

Glen Canyon National Recreation Area (NRA), Utah and Arizona, signed an interagency fish management plan last year to facilitate cooperative fish management and endangered species restoration in the recreation area. Of particular interest and specifically addressed in the plan are four endangered, four native, 10 sport, and six other park fish species.

Park waters are diverse and require different management approaches for species occupying different habitats. The plan establishes goals and objectives for fish species occupying five different habitats within the national recreation area: flowing rivers, inflow areas, Lake Powell, dam tailwater, and perennial or intermittent streams.

This cooperation facilitated the establishment of a memorandum of understanding (MOA) between the recreation area, the Utah Division of Wildlife Resources, and the U.S. Fish and Wildlife Service. The MOA authorizes release of marked, captive-reared, endangered fish into critical habitat. As a result, 297 endangered razorback suckers were released to mature in golf course ponds in Page, Arizona, a community adjacent to the park. This project is the core of a high school advanced biology course and is part of a 3-year, grant funded, education program between Glen Canyon NRA and the school. In May, 30 fish were fitted with transmitters and are now being tracked by National Park Service, Bureau of Reclamation, and USGS Biological Resources Division biologists.

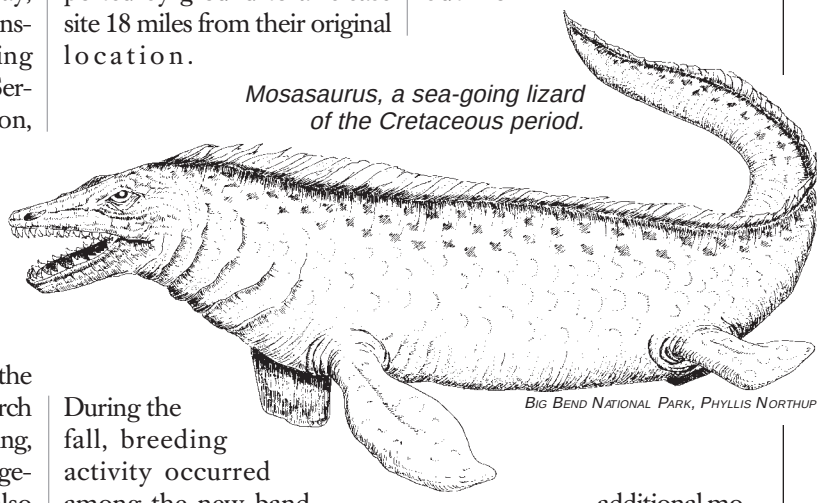
Interagency work to carry out the provisions of the fish management plan is accomplished through annual meetings for the review and approval of research proposals, planning monitoring, and coordinating fish management activities. The group also exchanges data and study results, pursues multiagency funding initiatives, and addresses research permit needs.

The plan has proven to be valuable. Management efforts are now better coordinated, goals and objectives are shared by all, and resource management activities are more efficient.

GREAT PLAINS

Bighorn Sheep Studied at Badlands

Between 1991 and 1995, Badlands conducted research on bighorn sheep as part of a NRPP (Natural Resource Preservation Program) initiative. The studies looked at population home range, habitat utilization, demographics, foraging ecology, disease ecology, and genetics. In 1995, data from these studies were paired with a GIS-based bighorn sheep habitat assessment, resulting in a management decision to restore sheep to large areas of unoccupied suitable habitat. The first translocation took place last October when 12 ewes and four young rams were netted by helicopter from the park's main herd, radio collared, and transported by ground to a release site 18 miles from their original location.



Mosasaurus, a sea-going lizard of the Cretaceous period.

BIG BEND NATIONAL PARK, PHYLLIS NORTHUP

During the fall, breeding activity occurred among the new band, and at least four mature rams from the source population were involved. By the end of winter, three of the four rams returned to their former bands. In May, nine ewes gave birth to 10 lambs; as *Park Science* went to press, eight ewes and nine lambs had survived. The park continues to monitor the effects of translocation on the source herd.

First Mosasaur Discovered at Badlands

In response to a visitor discovery last October, a park paleontological team verified the first fossil specimen of a mosasaur (genus Mosasaurus) at Badlands National Park, South Dakota, on November 8, 1996. A marine lizard, the mosasaur lived at sea 75 million years ago and fed on fish. The discovery is of a juvenile, about 15-feet long, perhaps half of adult size, and the team recovered part of the jaw and some vertebrae. Dr. Gordon Bell, visiting professor at the South Dakota School of Mines and Technology and a mosasaur expert, was among the field team. Follow-up field work has revealed other vertebrate fossils that provide more information about the time period in which the mosaur lived, but no additional mosasaur remains have been discovered.

Badlands is world famous for its assemblage of Oligocene-Eocene mammalian fossils and is the birthplace of North American paleontology. Recently, paleontologists have begun looking for fossils in older rock formations in the park, which are slowly yielding additional glimpses into the past. Under the direction of park paleontologist Rachel Benton, the less studied Pierre Shale of the Late Cretaceous period has been the subject of considerable scrutiny during the last 2 years. Such efforts paid off in the case of the mosasaur discovery, which was made in this older formation.

Snowmobiles continued from cover

gests adverse health effects can occur at lower exposure levels, and the standards have been criticized (Watson 1995; Greek and Dorweiler 1990).

Emission Studies

The increase in popularity of the snowmobile and its polluting emissions have increased concern that snowmobile pollution in parks is reaching significant levels. As a result, several researchers have conducted investigations to determine whether this concern is justified. All of their studies focused on measuring the amount of CO in areas frequented by snowmobiles.

During winter 1994-95, National Park Service employees monitored ambient levels of CO at the west entrance station to Yellowstone National Park. The purpose of their study was to determine if National Ambient Air Quality Standards for CO were being exceeded. During winter 1994-95, no NAAQS exceedences occurred during the NPS monitoring study at the west entrance station. However, investigators did take samples on the snowmobile trail for informational purposes. The 1-hour bag samples taken near the entrance exceeded 35 ppm at two sites and the 8-hour average CO concentration exceeded 8 ppm at one site (Yellowstone National Park 1995). Therefore, concentrations at the west entrance exceeded levels established by the government to protect public health. However, the sampling method and locations used to collect this informal data did not meet guidelines for determining NAAQS compliance. Therefore, the results did not require national or state officials to take action. However, the results are scientifically valid and indicate the potential exposure of snowmobile tourists to significant CO levels.

During winter 1995-96, an informal study was conducted at Flagg Ranch in Grand Teton National Park, Wyoming. The conclusion was the same as that from data gathered at the west entrance in Yellowstone, namely that tourists may be exposed to significant levels of CO. However, a violation of national standards is not expected under present traffic populations due to the siting criteria used to determine compliance with National Ambient Air Quality Standards.

In yet another informal study, Yellowstone National Park rangers fitted with sampling equipment drove from West Yellowstone, Montana, to Old Faithful in typical snowmobile tourist fashion. The 1-hour CO samples that they collected were as high as 36 ppm. This was a very informal investigation that nevertheless illustrates the exposure of snowmobile tourists to significant levels of CO.

National park visitors traveling on snowmobile trails may be exposed to significant levels of carbon monoxide

Because of the increasing concerns about pollution from snowmobiles and the informal data to this effect, we undertook an investigation to quantify and predict exposure to pollution for people who travel on a trail behind another snowmobile.

Our research objectives were to quantify the amount of CO emitted from a snowmobile under steady-state conditions, to quantify the amount of CO an individual is exposed to while driving behind another snowmobile as a function of speed and distance behind that snowmobile, and to develop a model to predict exposure to CO and other pollutants while traveling in the wake of a snowmobile.

Study Area and Methods

We performed all emission and exposure testing along a section of snowmobile trail in Grand Teton National Park (fig. 1, page 1). The trail was ideal for testing. It ran along a valley floor and was relatively flat and straight. Snowmobile traffic was light and did not interfere with controlled test conditions. Additionally, air inversions in this site in winter were strong and permitted us to take the exposure measurements in extremely calm conditions.

To determine the amount of CO emitted from a snowmobile under steady-state conditions, we measured the rate of airflow into the engine and collected bag samples of snowmobile exhaust while traveling at four different speeds over flat terrain (fig. 2). The speeds ranged from 10-40 miles per hour (mph) in order to cover the range of speeds usually occurring on park snowmobile trails. We then measured the CO concentration in each sample bag back at the lab (fig. 3). We used the data to calculate an average mass emission rate of CO for each speed.

To quantify the CO exposure of a following snowmobiler, we took bag samples at five different distances and four different speeds behind a moving snowmobile. We accomplished this by riding a second snowmobile at fixed distances behind the first snowmobile while collecting bag samples (fig. 4). The distances ranged from 25-125 feet. The speeds were the same as used in determining CO emission rates. We also took CO samples in the absence of a lead snowmobile so that we could correct the data for CO from self-exposure. Every effort was made to take exposure data under stable atmo-

Lori M. Snook Fussell

Figure 2. The study took place on flat terrain in Grand Teton National Park and involved a test snowmobile equipped for airflow measurement and exhaust sampling.

LORI M. SNOOK FUSSELL

Figure 3. Snowmobile exhaust was collected in bags in the field (arrow), diluted, and then analyzed in a laboratory. The canisters contain gases used to calibrate the carbon monoxide analyzer.

spheric conditions. We wanted to predict the maximum exposure possible for individuals that follow another snowmobile.

RESULTS

The average steady-state CO emissions ranged from 9.9 g/mile (99 g/hr) to 19.9 g/mile (795 g/hr) (Table 1, page 10). The current national CO emission standard for new cars is 3.4 g/mile (Black 1991). However, automobile emissions are measured while the vehicle is driven according to a prescribed driving schedule. Therefore, the CO emission standard for automobiles represents the average CO emitted from a vehicle under a variety of driving conditions including acceleration and idling. We measured CO snowmobile emissions under steady-state driving conditions only. Therefore a comparison of the CO emissions that we measured with automobile emissions would be improper. To compare the snowmobile emission results in our study with automobile emission standards, we must know the steady-state CO emissions from an automobile.

In a recent study at the University of Tennessee, Sluder (1995) measured steady-state CO emissions from a 1988 Chevrolet Corsica. For speeds ranging from 10-40 mph, the steady-state tailpipe emissions of CO ranged from 0.01 to 0.04 g/mile. These values are approximately 1,000 times smaller than the steady-state snowmobile emissions we measured in our investigation. Therefore, our results support the claim that snowmobiles produce significantly more CO than a present-day automobile.

JERRY B. FUSSELL

Figure 4. The study required a constant distance between the emitting snowmobile (front) and the trailing snowmobile that recorded the exhaust concentrations.

Average carbon monoxide exposure measurements (corrected for self-exposure) at speeds from 10-40 mph and distances of 25-125 feet ranged from 0.5-23.1 ppm (Table 2, page 10). The highest individual measurement was 45 ppm. In interpreting these data, one must remember that we measured CO exposure behind only one snowmobile. The average size of a snowmobile group in Yellowstone is eight snowmobiles (Machlis 1995). As many as 1,000 snowmobiles may travel to Old Faithful during one day, and, from the west entrance, the trip requires about an hour of driving at 40 mph. Considering that snowmobilers typically travel behind more than one snowmobile for sustained intervals, one can see that their exposure to CO is clearly significant. An additional consideration is that many snowmobile trails are located at high altitude. The general consensus among medical and air pollution professionals is that the risk to health from CO increases at high altitude, especially for unacclimated individuals (National Commission on Air Quality 1980). Therefore, a park visitor living at sea level who rides on high-altitude snowmobile trails is more susceptible to the effects of CO than local residents.

Using the emission and exposure data from our investigation, we developed a simple model to predict exposure to CO while traveling in the wake of a snowmobile. This model is valid under stable atmospheric conditions in no or light wind. We will also be able to use this model to predict exposure to the unburned hydrocarbons including air toxics present in snowmobile exhaust when information becomes available. This will provide useful information on exposure to pollutants other than CO without requiring more expensive testing.

IMPLICATIONS

The major implication of this research is that national park visitors traveling on snowmobile trails may be exposed to significant levels of CO. Although the steady-state exposure data from one snowmobile does not indicate average exposures greater than 35 ppm, many factors lead us to believe that CO exposure may be significant.

1. Snowmobile tourists typically travel in large groups. Exposure to CO for the last person in the group will be significantly higher than the concentrations we measured behind only one snowmobile.
2. Our investigation dealt with only steady-state conditions. Snowmobiles emit more CO when under power or accelerating. Therefore, the steady-state emissions we measured are a "best-case" emission volume. Exposure will increase at other than constant speed.
3. Park snowmobile trails force snowmobilers to travel directly behind other snowmobiles. The wake of leading snowmobiles cannot be avoided other than by keeping a large gap between snowmobiles.
4. Many park trails are at high altitude where the effect of CO on unacclimated people is intensified.

Continued on page 10

Continued from page 9

5. In many parks, air inversions are strong and create calm conditions that prevent the rapid dispersion of pollution.

Table 1. Average steady-state carbon monoxide emissions from a snowmobile

Speed (mph)	Average CO Emission (g/mile)
10	9.9
20	10.5
30	10.8
40	19.9

Table 2. Carbon monoxide exposure measurements at various speeds and distances. Each value is corrected for self-exposure and represents the average of 4-5 independent tests

Speed (mph)	Distance (ft)	Average CO Exposure (ppm)
10	25	23.1
	50	2.6
	75	0.5
	100	2.4
	125	5.1
20	25	13.0
	50	5.4
	75	2.4
	100	3.4
	125	1.8
30	25	12.1
	50	5.0
	75	3.5
	100	6.69
	125	3.0
40	25	19.6
	50	11.1
	75	8.6
	100	8.9
	125	8.4

6. Many trips on national park snowmobile trails require several hours of driving, increasing exposure to CO.
7. Exposure data from our study were corrected to disregard self-exposure to CO. We measured as much as 10 ppm of CO from self-exposure under steady-state conditions. This self-exposure is expected to increase with a tailwind or while decelerating.

Suggestions

The exposure to pollution from snowmobiles on park snowmobile trails may be reduced by a reduction in the emissions from snowmobiles, a decrease in the numbers of snowmobiles on park trails, and avoidance by snowmobilers of stable weather conditions and high-density traffic where significant exposure may occur.

Reducing the emissions from snowmobiles is the most desirable option. In this way, snowmobilers may continue to enjoy popular destinations without restriction. It *is* possible to make snowmobiles less polluting. One easily implemented first-step is requiring the use of oxygenated fuels. A recent study on small two-stroke engines (Sun et. al. 1996) concluded that oxygenated fuels can reduce UHC and CO emissions by 10-20%. Additionally, their high octane rating can improve engine performance. During winter 1996-97, Yellowstone National Park snowmobiles were run on oxygenated fuels to evaluate the feasibility of this alternative. Other technological options include switching to a small, four-stroke engine with conventional pollution control equipment, running a two-stroke engine slightly lean with catalytic after-treatment, or using a two-stroke engine with fuel injection (with a redesigned combustion chamber). All of these solutions will increase the cost of snowmobiling.

Decreasing the amount of snowmobilers on park trails is the most controversial solution. However, if emissions from snowmobiles are not reduced voluntarily, this may be the only effective option.

Finally, snowmobile tourists should be warned of the potential exposure to pollution and taught to recognize early signs of excessive exposure. They can decrease their own exposure by traveling in small groups, touring on windy days, turning off the engines of stationary snowmobiles, avoiding popular destinations during peak season, driving far behind other snowmobiles, and by driving off-centerline whenever safe and legal.

PS

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A Nontraditional Cooperative Approach to Natural Resource Management

Timber Harvest Will Lead to Area Restoration at Timucuan Ecological and Historic Preserve

Daniel R. Tardona

Figure 1. Planted stands of slash pine and loblolly pine are scheduled for harvest in 2002 at Timucuan. The vegetation restoration plan, developed to guide the transfer of land ownership to the National Park Service, allows for commercial harvest of the trees by the property owner, who will fund subsequent restoration of the site to a more natural condition.

By Daniel R. Tardona

The Timucuan Ecological and Historic Preserve is a 46,000 acre unit of the national park system that was established in 1988 to protect wetlands and uplands in Duval County, Florida. Unlike many traditional units, the Timucuan Preserve consists of publicly and privately owned lands. Approximately 8,000 acres are owned by the National Park Service with the remainder owned by many different private and governmental parties.

The Castleton Beverage Corporation, a subsidiary of the Bacardi Corporation, owned approximately 927 acres of ecologically and culturally significant land in the preserve. Known as the Thomas Creek Area, the Castleton property contained open fields, numerous small ponds, a 27-acre lake (a borrow pit), 262 acres of fresh water wetlands, and approximately 145 acres of brackish marshlands. A few dirt roads provide access within the property. The upland portions of the site have been used for silviculture by Castleton. Loblolly pine *(Pinus taeda)* and slash pine *(Pinus elliotii)*, originally planted in rows on raised beds, were to be harvested by the corporation when the trees attained their maximum value as timber (fig. 1). Castleton had planned to cut nearly all the stands of trees on the site including natural stands of slash pine and pond pine *(Pinus serotina)*. After harvesting, Castleton planned to explore options offering the most economic benefit including sale of the land for development.

Land Acquisition

The Timucuan Ecological and Historic Preserve is mandated to ensure that current and future uses of uplands inside and adjacent to its boundaries do not impair significant natural habitats, water quality, or healthy salt marsh and estuarine systems. The planted forest in the Thomas Creek Area was not in keeping with the mandates of the preserve, and acquisition and subsequent restoration of the vegetative cover could have been too costly. Consequently, the administration of the preserve pursued a nontraditional approach in the acquisition of the land from the Castleton Beverage Corporation beginning in 1990. Ultimately, the land was acquired through a combination of a land donation and public and private funding to purchase the remaining portion. The land acquisition contract required the development of a vegetation management plan for a transition of the vegetative cover from a pine plantation to natural vegetation of the area.

Vegetation Plan

Staff from the preserve and Great Smoky Mountains National Park along with a forester from the Castleton Corporation and various professionals from other state and local resource management agencies produced the vegetative resource management plan. According to the plan, all loblolly pine and slash pines will be harvested in 2002. Natural slash pine stands that provide buffer zones around the lake and along wetland margins will not be removed. Selected stands of natural slash pines will be thinned in order to improve species reproduction and to create a mixed two-aged stand of slash pine and longleaf pine. All pond pine stands will be left in place. After harvesting, the Castleton Beverage Corporation will fund restoration of the site. This will include planting longleaf pine *(Pinus palustrus)* in designated harvested areas at different times in order to achieve a multiple age effect and mimic natural regeneration over several years. The plan is expected to return the area to a more natural vegetative state as observed by presettlement visitors to the area.

The Castleton Beverage Corporation will realize the economic value of the timber that under traditional NPS land acquisition methods would have been lost. If the property had been acquired by the National Park Service without the removal of the loblolly pine, long and costly removal of the trees and transition of the site to a natural state probably would have taken years and may possibly have been cost prohibitive. The nontraditional cooperative approach to the acquisition and management of natural resources demonstrates that tangible benefits for conservation and for the corporate world can be accomplished without compromising the NPS vision of resource protection.

PS

Dan Tardona is the West District Supervisor in the Interpretation and Resource Management Division at Timucuan Ecological and Historic Preserve in Jacksonville, Florida. His phone number is (904) 641-7155.

Does the Public Care about Research and Inventory Projects in the Parks?

The First Fire Island National Seashore Science Conference

By Michael Bilecki

Over the past 2½ years, Fire Island National Seashore in New York has hosted several public meetings about various park planning projects. The meetings facilitated good discussion on the issues and also prompted many unanticipated, but welcome, questions about research projects going on in the park. To satisfy this interest in park research, the staff of the seashore decided to hold a public meeting to introduce a few of the research projects just beginning at the park. Despite making announcements in the press, no one attended the meeting–it was a complete flop! This left us wondering if we had gauged correctly the level of interest in science and its application in the park. Perhaps we erred in scheduling it on the island and during the summer when residents and renters are on vacation and relaxing. Also, logistical problems with boat travel for non-island residents may have played into the lack of attendance.

When I discussed the outcome of the meeting with Dr. Mary Foley, Chief Scientist, New England Support Office, she suggested that maybe it was time for Fire Island to hold a science conference. Designed to be more comprehensive than the failed effort, the science conference would introduce both new and ongoing research and inventory projects, from shoreline change to estuary monitoring, and their principal investigators. More summaries would be planned and a direct mailing would publicize the event. We still felt strongly that this would be a good opportunity to show how the data being collected are helping us make various decisions related to resource protection.

Planning the Conference

With so many researchers and grad students conducting research in the seashore, we soon recognized that the conference could last at least 2 days. Because this was to be the first Fire Island National Seashore Science Conference, we decided to start with a 1-day event and focus only on those projects receiving at least some funding from the National Park Service. We ended up with 12 projects from 10 presenters (table 1).

Cost to the park was a concern initially, but ended up being minimal. I spent quite a few hours on the phone discussing topics and the focus of the event with the researchers. Logistics was accomplished efficiently by the resource management staff without spending a great deal of time.

To publicize the event, we created a three-fold brochure-invitation that included a schedule of presentations and mailed it to more than 175 parties using our resource management mailing list. Recipients ranged from individuals with interest in the seashore, home owners, and community associations, to environmental groups, special use groups, universities, and local, state and federal agencies. In contrast with our earlier, failed effort, 80 people signed in at the conference and more than 100 people were counted in the audience.

Impact of the Conference

The conference received rave reviews. Not only did the newspapers print positive stories about it, but the park received a few letters and phone calls from organizations, agencies, and the public telling us how much they appreciated the opportunity to learn more about our work at the seashore.

Perhaps the biggest reason it was well attended was because we targeted invitations and held the conference in January. Also, the presentations were diverse enough to create interest among the many agencies, interest groups, and organizations.

The value of the conference can be measured in various ways. For the park, learning the status of projects and hearing the presentations will be very useful to our inventory and monitoring planning efforts. The most beneficial and exciting aspect from my perspective was bringing the researchers together in one place so that the public, other agencies and resource managers, public officials, and park staff could meet and talk with them. The various groups who attended the conference may not have all agreed with the data or the focus of a research or inventory project, but they did appreciate that the seashore made an effort to share the information and its application in the decision making process.

For their part, the researchers also felt the conference was beneficial. After the conference, Dr. S.S. Mitra (Department of Natural Resources Science, University of Rhode Island) said, "The conference provided a valuable overview of the breadth of scientific research conducted on the national seashore, and it fostered communication among the diverse communities committed to Fire Island's natural resources."

Putting together the conference was not easy, but overall, the organization and preparation were well worth the effort. We hope to make this a biennial event. PS

Table 1. Presentations at the Fire Island Science Conference

Birds, Mammals, Ticks, and Lyme Disease at the Fire Island Lighthouse Tract:
Project Overview and Migratory Bird Phenology and Residence Times
Tick Populations and Transmission Dynamics of Lyme Disease Spirochetes
Tick Burdens and Population Status of Small Mammals and Deer
Contraceptive Management of Fire Island Deer
Density and Herd Composition of White-Tailed Deer Populations
Estuarine Resources: Focus on Nekton Communities
Beach Invertebrates
Freshwater Wetlands Delineation and Inventory of Wetland Herpetological Species
Ecology of Red Foxes on Fire Island: A Proposal
Fire Island Deer Exclosure Study 1985-1995
Predicted Effects of Potential Breaches on Tides and Salinity in Great South Bay
Time and Space Scales of Shoreline Change at Fire Island, 1870-1996

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PARK SCIENCE INDEX—1996

ALPHABETICAL BY AUTHOR, PARK, AND KEYWORD

Editor's Note: *Entries pertain to volume 16 (1996) numbers 1-4 (winter, spring, summer, fall, respectively). Issue number is shown in parentheses, followed by page numbers where the article containing the referenced entry can be found.*

PS

1996 Park Science Feature Articles in Summary

by General Subject

Donna L. DiFolco

Ecosystem Management

- The National Park Service took a step toward ecosystem management by participating in an ecological stewardship workshop in Tucson, Arizona **(2):**13-14. With a book planned as a product, the gathering generated many reflections on the meaning of ecosystem management to this agency **(2):**15.
- Further evidence that ecosystem management is beginning to come of age was the review of the Keystone Center meeting in Colorado on this holistic management approach **(1):**10.
- Members of Partners in Flight, the international program for the conservation of neotropical migratory songbirds, convened a workshop in late 1995 and began drafting a conservation plan aimed at building consensus and consistency among the many disparate working groups that make the program fly **(1):**11,19 (logo, top).
- National Biological Service research scientists Gary Davis and Bill Halvorson released their timely book, *Science and Ecosystem Management in the National Parks,* an argument for the continuation and application of science and monitoring in parks **(2):**5.

Restoration

- Just 3 years after restoring a portion of Kenilworth Marsh in Washington, D.C., park resource managers noted the return of the Long-billed Marsh Wren, a positive indication of corrected wetland function **(4):**9.
- Lincoln Boyhood National Memorial, Indiana, applied grant funds to an ambitious reforestation project that returned native hardwoods to two meadows near the park visitor center **(4):**28-29.

Resource Assessment

- Threatened by landslides resulting from over saturated perched aquifers, Hagerman Fossil Beds National Monument, Idaho, undertook a landslide factor assessment procedure to identify likely new areas of impact to fossil resources. Armed with new information, the park established a monitoring program and adjusted their excavation priorities to safeguard the fossils most at risk **(2):**20-23.
- Hydrologists from the Natural Resource Program Center described a simple field technique for assessing the condition of riparian-wetland areas, the first stage in restoring the proper function of wetlands **(4):**22-24.

GIS

- Geographic information systems proved invaluable in mapping the fire perimeter, locating and assessing damage to sensitive resources, and tracking restoration efforts during the Vision wildfire at Point Reyes National Seashore, California **(4):**25-27,29 (bottom photo, left).

Inventory & Monitoring

- Surveys at Gates of the Arctic National Park and Preserve, Alaska, revealed that the candidate threatened plant *Aster yukonsensis* was more common than previously known **(2):**18-19 (middle photo, left).
- Investigators intensively studied desert rock pool systems in Capitol Reef National Park, Utah. The effort resulted in sound baseline data and knowledge of more than twice as many aquatic species as previously recorded **(3):**14.
- Researchers at Sleeping Bear Dunes National Lakeshore, Michigan, enumerated many of the problems, issues, and compromises they encountered in maintaining a water quality monitoring program. Among the challenges were continuity in field personnel, gaps in information, and funding for consistent sampling **(3):**19-21 (top photo, left).

Conferences

- Yellowstone National Park (Wyoming, Montana, and Idaho) hosted a popular conference exploring the ecology and conservation of predatory mammals **(1):**14-15. The park also convened a 4-day symposium on the biodiversity, ecology, and evolution of hot water organisms where managers, academicians, and biotech companies discussed the contributions to society of biologically diverse, publicly owned resources **(1):**12-13,19. Similarly, Yellowstone investigated access and property rights to genetic resources at an international conference **(4):**12-13.
- Held in Boise, Idaho, the Tall Timbers Fire Ecology Conference explored the ongoing shift in the paradigm of fire management from suppression to prescription **(4):**11,30.

Administrative Adjustments

- Agency restructuring and downsizing shifted resources from central offices to parks, erased familiar planning processes, complicated communication, and reduced technical support; it also increased cooperation in the field, empowered superintendents, and left resource managers pondering how to make the changes work to the benefit of natural resource preservation **(1):**24-28.
- A National Biological Service ecologist examined the continuing need for science-based management of parks and the dynamic relationship between the National Biological Service and the National Park Service **(2):**10-12. The report also forecast the merger of the National Biological Service with the U.S. Geological Survey **(2):**11.

Research

- Research at Apostle Islands National Lakeshore, Wisconsin, pointed to low food availability as a primary cause of reduced bald eagle reproduction in the park and vicinity **(3):**22-23,26.
- Trampled incessantly by millions of urban park visitors, turfgrass must be matched to the intended use and climate to hold up under these pressures **(3):**30-31. Research conducted on the National Mall in Washington, D.C., suggested many specific improvements for parks in the use of this utilitarian natural resource **(3):**27-29.
- Necessitated by road construction, Glacier National Park, Montana, and several cooperators investigated the regenerative capabilities of native conifers and herbaceous species. The information will help the park and a neighboring experimental forest to plan for optimum recovery of native vegetation following such disturbances **(1):**20-21.

The Scientific Method

- National Park Service contaminant specialists Roy Irwin and Lynnette Stevens pointed out some of the pitfalls of pseudoreplication, a problem not uncommon in ecology research where findings can mistakenly be applied too broadly. Researchers must pay especially close attention to true replication of results in drawing valid conclusions **(2):**28-31.

Park Science

- An index of *Park Science* articles published in 1995 (like this one) reminded readers of the variety and complexity of natural resource problems we face and the equally innovative solutions matched to the task of resource preservation **(4):**29-31.
- The MAB Notes column in this publication changed its focus in 1996 from reports on the activities of the Man and the Biosphere National Committee to biosphere reserve parks. Along those lines, the Mammoth Cave Area Biosphere Reserve, Kentucky, reported on its progress with groundwater protection due, in part, to the biosphere reserve designation **(3):**12-13.

New Techniques

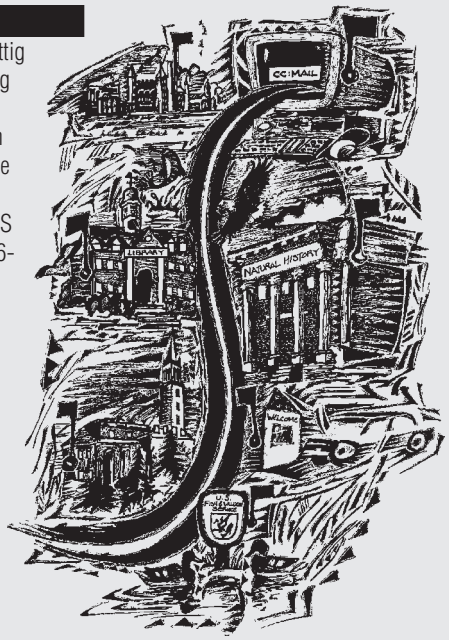
- Cape Cod National Seashore, Massachusetts, shared its experience with FACA, the Federal Advisory Commission Act, and negotiated rule making as resource and visitor management tools to resolve an ongoing contentious issue—off-road vehicle use on park beaches **(2):**1,16-17,21 (top photo, right).
- The National Park Service tested and adopted a new process for awarding construction project funds based partly on the benefits such work brings to natural resource preservation **(4):**19-21,30.

Professionalization

- Participants in the Natural Resource Trainee Program of the 1980s and early 1990s spoke out about the positive effect the course had on the professionalization of resource management in the National Park Service **(3):**1,16-18 (bottom photo, right).

Information Management

- National Park Service biologist Stephen Fettig detailed a method for locating and retrieving biological information over the Internet for users of the NPS cc:Mail e-mail system. An indication of how commonplace World Wide Web technology is becoming, this report seems dated after just one year as more NPS staff connect directly to the Internet **(1):**1,16-19 (illustration, top).



Economics

- Social scientists detailed a technique for assessing regional economic contributions from national park system units to local area economies **(2):**24-26. In the hands of a superintendent, this knowledge facilitates better integration of park goals and resource preservation purposes in the planning activities of park gateway communities **(2):**26-27.

Education

- The rapidly growing *Leave No Trace* program imparts low-impact camping and travel skills and a wildland ethic to park users and provides managers with an educational solution for reducing visitor impacts to natural areas **(3):**24-26.

New Information

- Often overlooked in resource management planning and activities, butterflies and moths provide numerous benefits to parks. A survey of northeastern United States national parks, state parks, and national wildlife refuges reflected a growing interest in the management of these insects **(4):**1,16-18.

Paleontology

- With the help of a scanning electron microscope, researchers journeyed into the micron-sized world of fossil diatoms, redwoods, and sediments that existed 35 million years ago at Florissant Fossil Beds National Monument, Colorado, and revealed a rich geological history of Lake Florissant **(1):**22-23 (middle photo, right).
- Paleontologists and resource managers at Curecanti National Recreation Area, Colorado, excavated Late Jurassic dinosaur remains little known from the region. The new discoveries thrust paleontological resources into the limelight for this park and increased our knowledge of the distribution of dinosaurs during this time **(4):**14-15.

PS

Meetings of Interest

SEPTEMBER 20-22 The American Association of Wildlife Veterinarians is sponsoring the workshop, "Wildlife Capture, Immobilization, and Safety," to take place in Fort Collins, Colorado. Topics covered include pharmacology of capture drugs; legalities of drug use; calculating drug doses; handling and care of ungulates, carnivores, and birds; equipment and techniques; and animal and human emergency treatments. The course will include actual immobilization of ungulates at facilities operated by the Colorado Division of Wildlife. For more information, contact Terry Kreeger, Wyoming Game and Fish Department, 2362 Highway 34, Wheatland, WY 82201; (307) 322-4576; tkreeger@uwyo.edu.

SEPTEMBER 21-23 Snowmass, Colorado, will be the venue for the "Forum on Wildlife Telemetry: Innovations, Evaluations, and Research Needs." Topics will include innovations and field evaluations of transmitter and receiving systems and methods, attachment techniques, collection of physiological and environmental data using telemetry, data processing and analysis, and meeting future research needs through telemetry development. For more information, contact Jane Austin or Pam Pietz, USGS Biological Resources Division, Northern Prairie Science Center, 8711 37th Street SE, Jamestown, ND 58401; jane_austin@nbs.gov or pam_pietz@nbs.gov.

OCTOBER 12-14 Yellowstone National Park will host the Fourth Biennial Scientific Conference on the Greater Yellowstone Ecosystem at Mammoth Hot Springs Hotel. Billed as a celebration of the 125th anniversary of the park, the conference has the theme: "People and Place: The Human Experience in Greater Yellowstone." Presentations and panel discussions will explore historical and contemporary perspectives on the ecosystem, including indigenous peoples, rural and urban communities, work and daily life, tourists and tourism, human perceptions of nature, cultural heritage preservation and management, scientific ideas and their impact on park management, the history and philosophy of the national park idea, and others. Details on conference registration, travel, lodging, and camping are now available; contact Joy Perius, Yellowstone Center for Resources, at (307) 344-2209, or look for the World Wide Web site at *http://www.nps.gov/yell/ycr.htm.*

MAY 17-22, 1999 The University of Montana Center for Continuing Education has begun planning for the conference, "Wilderness Science in a Time of Change," to be held in Missoula, Montana. The conference will present research results and synthesize knowledge as it relates to the management of wilderness. Plenary sessions will explore the values of the transactions between science and wilderness; the need to improve the definition of wilderness; and the implications of changing societal definitions of wilderness, increasing technological development, and mounting external pressures. A call for papers will be issued later this year. For more information, contact the Center for Continuing Education at the University of Montana, Missoula, MT 59812; (406) 243-4623 or (888) 254-2544 (toll-free); or ckelly@selway.umt.edu.

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